PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P/63773/GPTX18	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IB 03/05115	International filing date *(day/month/year)* 13.10.2003	Priority date *(day/month/year)* 31.10.2002
International Patent Classification (IPC) or both national classification and IPC H04B10/17		
Applicant MARCONI COMMUNICATIONS SPA		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
27.05.2004	31.03.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Cochet, B Telephone No. +31 70 340-4464

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB 03/05115

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

2-4, 6-14	as originally filed
1, 1a, 5	filed with telefax on 30.11.2004

Claims, Numbers

19, 20	as originally filed
1-18	filed with telefax on 30.11.2004

Drawings, Sheets

1/3-3/3	as originally filed

2. With regard to the **language,** all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document :

D1: US-A-6 160 657 (LEE SEUNG-HEE ET AL) 12 December 2000 (2000-12-12)

1. **Article 33 PCT**

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document) a means for controlling the gain of an optical amplifier (col. 2, l.21-29) comprising a source for generating a gain control signal (col. 2, l. 35-37), an optical amplifier for receiving one or more optical input signal channels at the first end (col. 2, l. 33-35) and means for providing the gain control signal at the other end (fig. 2)

The subject-matter of claim 1 differs from this known D1 in that the source is arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering **in** the optical amplifier (in D1, the Brillouin scattering is produced is an extra stage 24, fig. 1)

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to simplify the amplifier arrangement.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT), because nowhere in the prior art is hinted such a use of a Brillouin scattering process in an optical amplifier.

The same reasoning applies for the corresponding method claim 12.

Claims 2-11,13-20 are dependent on claims 1 and 12 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

2. Additional remark under **Article 6 PCT**

The applicant is informed that the independent claims as they stand now still present unclarity which could be objected when entering regional phase. It has been understood from the description that the gain control signal produces Brillouin scattering amplification in an optical amplifier which uses **another kind** of optical amplification process, e.g. Raman amplification or EDFA amplification, so that two different types of amplification occurs in the same optical amplifier. However, the independent claims are so broadly claimed that they could possibly be interpreted as covering the case of a simple Brillouin amplifier, where the "gain control signal" would be the Brillouin pump used to produce SBS amplification in the optical (Brillouin) amplifier. In that case, any document disclosing a Brillouin amplifier with a counter-propagating Brillouin pump signal would become a novelty destroying document for the independent claims. The applicant is therefore kindly advised to find a clearer wording for the independent claims, when entering regional phase, so that it is clear that the Brillouin amplification process occurs with another type of amplification in the optical amplifier, in order to avoid any possible clarity objection at a further stage.

OPTICAL SYSTEM

The present invention relates to the field of optical systems in general and, in particular, to means for controlling the gain of optical amplifiers.

Several types of optical amplifier have been proposed to overcome the effect of signal attenuation in optical transmission paths, particularly fibre. These amplifier types include erbium doped fibre amplifier (EDFA), Thulium doped Silica fibre amplifier (TDSFA), Thulium doped Telluride amplifier (TDTFA), lumped Raman amplifier (RA) and distributed RA.

US-A-6 160 657 to Lee Seung-Hee et. al., describes a non-Raman optical amplifier in which the levels of signals output from the amplifier is limited during changes in the number of input optical channels by use of stimulated Brillouin scattering generated in a separate, non-linear stage and fed to the output of the gain stage.

US-BI-6 441 950 to Chen Chien-Jen et. al., describes a distributed Raman amplifiers and a conventional arrangement for measurement of optical signal power levels and for controlling amplifier gain to compensate for changes in power levels not using Brillouin scattering.

Raman gain in an optical network is an extremely important means for compensating for signal attenuation or loss in transmission fibre by exploiting stimulated Raman scattering

(SRS). Lumped RA and EDFA differ from distributed RA inasmuch in that they exploit as the amplification medium a short length of specially doped fibre with tailored mechanical and optical features. The distributed RA exploits instead the normal transmission fibre as the amplification medium. It differs from lumped RA and EDFA because the amplification medium (the fibre) is not located within a restricted space but can extend over hundreds of kilometres exploiting legacy transmission fibre. Lumped RA and EDFA may be considered as providing optical amplification at a single point of the network, whereas the distributed RA provides optical amplification throughout most of the transmission fibre.

The object of the present invention is to overcome the above shortcomings and to provide an improved means of controlling gain in an optical amplifier. This object is achieved by use of a gain control signal. Ideally, the control signal should be at a high level where the signal channels are at a low level and vice versa in order to achieve a constant total power in the fibre along the whole length.

The present invention provides a means for controlling the gain of a optical amplifier comprising a source for generating a gain control signal, an optical amplifier for receiving one or more optical input signal channels at a first end and means for providing the gain control signal to the optical amplifier at the other end; in which the source is arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier.

The present invention also provides a method of controlling the gain of an optical amplifier comprising the steps of introducing one or more optical input signal channels into a first end of the optical amplifier, generating a gain control signal and introducing the gain control signal at the other end of the optical amplifier, in which the gain control signal is generated at a power level that produces stimulated Brillouin scattering (SBS) in the optical amplifier.

CLAIMS

1. A means for controlling the gain of an optical amplifier characterised in that it comprises a source for generating a gain control signal, an optical amplifier for receiving one or more optical input signal channels at a first end and means for providing the gain control signal to the optical amplifier at the other end; in which the source is arranged to generate the gain control signal at a power level that produces stimulated Brillouin scattering in the optical amplifier.

2. The means according to claim 1 comprising control means for identifying a change in the input signal and for varying the gain control signal power level to compensate for the identified change.

3. The means according to claim 2 in which the control means comprises monitor means for monitoring the power of the input signal and for varying the gain control signal power level to compensate for changes in the monitored power.

4. The means according to claim 2 or 3 in which the control means comprises means for obtaining information on the input signal channel or channels from an optical supervisory channel or pilot tone.

5. The means according to any above claim in which the gain control signal falls within the gain bandwidth of the optical amplifier.

6. The means according to any above claim further comprising means for monitoring the power level of the gain control signal.

7. The means according to any above claim in which the amplifier is a Raman amplifier.

8. The means according to claim 7 in which the amplifier is a distributed Raman amplifier

9. The means according to any one of claims 1 to 6 in which the amplifier is a rare earth doped fibre amplifier.

10. An optical amplifier comprising the means according to any one of claims 1 to 9.

11. An optical communications system comprising the means according to any one of claims 1 to 9 or the amplifier according to claim 10.

12. A method of controlling the gain of an optical amplifier characterised in that it comprises the steps of introducing one or more optical input signal channels into a first end of the optical amplifier, generating a gain control signal and introducing the gain control signal at the other end of the optical amplifier, in which the gain

control signal is generated at a power level that produces stimulated Brillouin scattering in the optical amplifier.

13. . The method according to claim 12 including the steps of identifying a change in the input signal and varying the gain control signal power level to compensate for the identified change.

14. The method according to claim 13 including the step of monitoring the power of the input signal and varying the gain control signal power to compensate for a change in the monitored power.

15. The method according to claim 13 or 14 including obtaining information on the signal channels from an optical supervisory channel or pilot tone.

16. The method according to any of claims 12 to 15 in which the gain control signal falls within the gain bandwidth of the optical amplifier.

17. The method according to any of claims 12 to 16 further including the step of monitoring the power level of the gain control signal.

18. The method according to any of claims 12 to 17 in which the amplifier is a Raman amplifier.